The Influence of Statistical Variations on Image Quality

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ABSTRACT

For more than thirty years imaging scientists have constructed metrics to predict psychovisually perceived image quality. Such metrics are based on a set of objectively measurable basis functions such as Noise Power Spectrum (NPS), Modulation Transfer Function (MTF), and characteristic curves of tone and color reproduction. Although these basis functions constitute a set of primitives that fully describe an imaging system from the standpoint of information theory, we found that in practical imaging systems the basis functions themselves are determined by system-specific primitives, i.e. technology parameters. In the example of a printer MTF and NPS are largely determined by dot structure. In addition MTF is determined by color registration, and NPS by streaking and banding.

Since any given imaging system is only a single representation of a class of more or less identical systems, the family of imaging systems and the single system are not described by a unique set of image primitives. For an image produced by a given imaging system, the set of image primitives describing that particular image will be a singular instantiation of the underlying statistical distribution of that primitive. If we know precisely the set of imaging primitives that describe the given image we should be able to predict its image quality. Since only the distributions are known, we can only predict the distribution in image quality for a given image as produced by the larger class of 'identical systems'.

We will demonstrate the combinatorial effect of the underlying statistical variations in the image primitives on the objectively measured image quality of a population of printers as well as on the perceived image quality of a set of test images. We also will discuss the choice of test image sets and impact of scene content on the distribution of perceived image quality.

Keywords: Image Quality, Statistical variability, Joint probability